BROWNS LAKE STOCKING ASSESSMENT & FISHERY MANAGEMENT RECOMMENDATIONS

Photo by D. Schmetterling

W. Ladd Knotek & William J. Schreck

Montana Fish, Wildlife & Parks
Missoula, Montana

May 2014

Montana Fish, Wildlife & Parks

SPORT FISH RESTORATION

Table of Contents

Executive Summary

Browns Lake is a large, relatively shallow kettle lake located in the center of the Blackfoot River valley near Ovando, Montana. This productive (meso-eutrophic) lake provides a popular, harvest-oriented rainbow trout fishery supported by stocking of hatchery-raised fish. Arlee and Eagle lake strain rainbow trout are currently planted annually (3-6 inch, young-of-year) in both late spring and fall. With the exception of occasional wild brook trout, stocked rainbow trout are the only sport fish present. Browns Lake provides a year-round fishery that currently supports 10,000-15,000 angler days based on statewide mail surveys (FWP Statewide Angler Pressure Estimates 2011- 2013). Standard angling regulations allow a creel of five rainbow trout daily, including one fish that may be greater than 22 inches total length. This regulation allows liberal harvest and has maintained a limited trophy fishery.

In 2008-2013, Montana Fish, Wildlife & Parks (MFWP) increased monitoring effort and scrutiny of stocking practices on Browns Lake. This project was implemented to develop management recommendations that would improve rainbow trout size structure (harvest quality) and fishery consistency (year-to-year angler success). The assessment described in this document was accomplished through incremental changes in stocking practices (e.g., methods, timing, location, number of fish, type and size of fish), coupled with standardized monitoring techniques (e.g., gill netting). Formal creel surveys were not conducted as part of this project.

Population characteristics suggest comparatively high growth rates and body condition for stocked rainbow trout in Browns Lake relative to other put-grow-and-take coldwater fisheries at western Montana lakes. As we incrementally increased stocking rates, refined plant methods and improved the quality of stocked fish over the course of this study, growth rates and body condition declined. However, limited creel data and anecdotal reports indicated a concurrent increase in angler catch rates, satisfaction and overall use. These trends facilitated further refinements in stocking rates and methods to balance catch rates and quality of angler catch.

Growth, body condition and age at maturity varied between the two strains of rainbow trout planted in Browns Lake. Arlee strain rainbow trout generally grew faster and maintained higher body condition than the Eagle Lake strain, but rarely survived to age three. Eagle Lake rainbow trout tended to mature later and comprised the majority of trophy (>22 inch) fish in the lake. Evaluation of triploid (sterile) Arlee rainbow trout stocking in 2008-2009 indicated poor survival and limited return to anglers. Based on these initial trials, future stocking of triploid rainbow trout is not recommended until successful planting regimens are demonstrated at comparable water bodies.

Limiting factors for the Browns Lake trout fishery include stress associated with low oxygen levels (winter and possibly summer) and high water temperatures in late summer. Consistent, high lake levels appear to mitigate environmental stressors and enhance lake productivity. High angler harvest rates are likely also a limiting factor for the trophy component of the fishery, despite high trout growth rates and liberal stocking.

Public access at Browns Lake is provided through public holdings on both state and federal lands, as well as private property leased by MFWP as a developed Fishing Access Site (FAS). While MFWP's goal is to maintain the current level and layout of public access at Browns Lake, alternative sites for boat access and parking on public parcels are being considered because of year-to-year uncertainty associated with the FAS lease and escalating costs. Recent limitations on other (walk-in) private lands access have emphasized the importance of securing and expanding shoreline fishing opportunities on private parcels.

Study Area

Browns Lake is a large (528 ac), relatively shallow (max depth 27 ft), natural lake located in the Blackfoot River valley near Ovando, Montana (Figure 1; Appendix A). For decades, Browns Lake has supported a popular and extremely productive put-grow-and-take rainbow trout fishery. Angling pressure occurs year round and now exceeds 15,000 angler-days per year (MFWP 2013). Despite annual stocking with two strains of fingerling rainbow trout, catchable trout density and the quality of the fishery have been variable. This variability has been attributed to inherent instability in the lake environment and inconsistent survival of hatchery plants.

In 2007-2013, Montana Fish, Wildlife & Parks (MFWP) increased monitoring effort and scrutiny of stocking practices on Browns Lake. The objective of this project was to develop management recommendations that would improve the size structure (i.e., harvest quality) and consistency (i.e., year-to-year angler success) of the rainbow trout fishery. This was accomplished through incremental changes in stocking practices (e.g., methods, timing, location, number of fish, type and size of fish), coupled with standardized monitoring (e.g., gill netting).

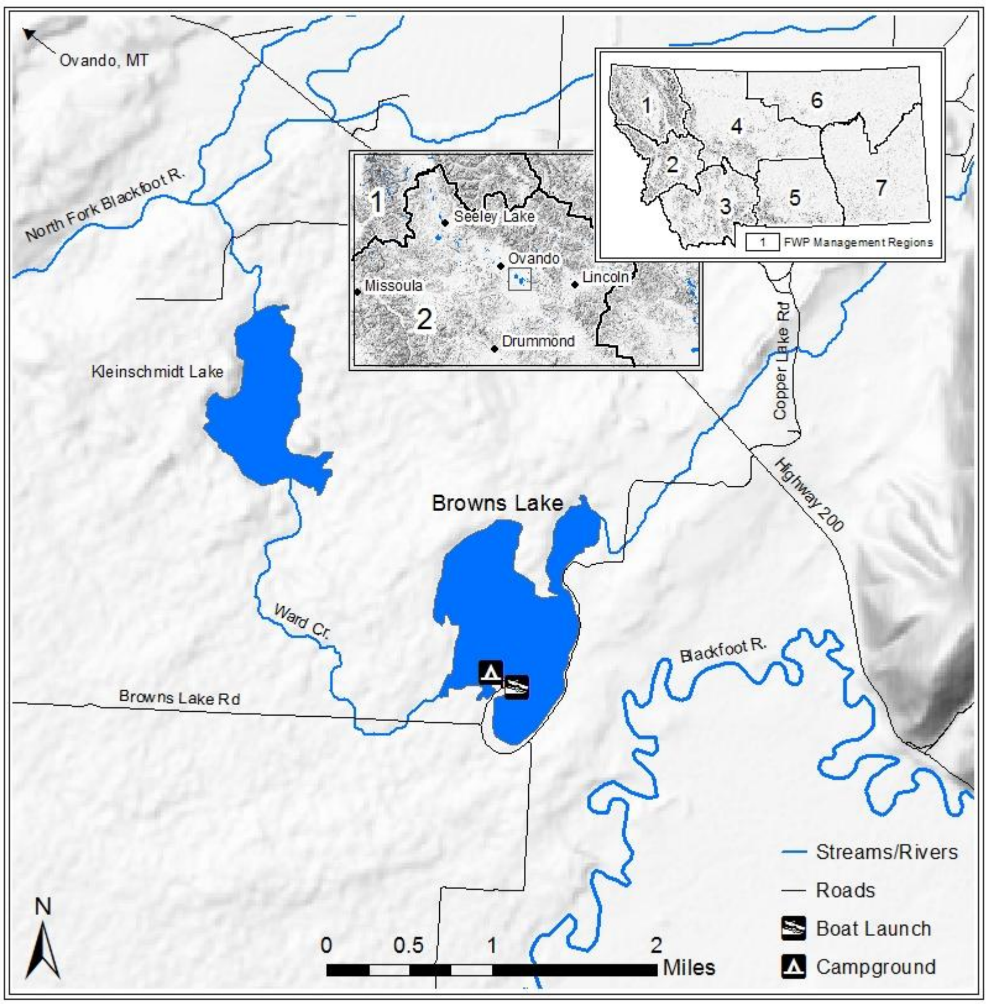


Figure 1. Location of Browns Lake in west-central Montana.

Context of the Browns Lake Fishery

West-central Montana rivers support several renowned wild trout fisheries, including Rock Creek and the Bitterroot, Blackfoot, and Clark Fork Rivers. The quality and sustainability of these heavily-used fisheries largely depends on restrictive harvest regulations, habitat protection, and constituents committed to catch-and-release angling. In contrast, lakes, reservoirs and ponds in the region are often managed to provide fishery diversity and greater harvest opportunity.

Georgetown Lake and Browns Lake are the two primary waters in west-central Montana (MFWP Region 2) that are managed as high quality, harvest-oriented trout fisheries. Although numerous other high elevation "mountain" lakes and a limited number of valley lakes and reservoirs are available to trout anglers, they are often too unproductive or contain too many competing fish species to support sustainable opportunity for larger trout, high levels of fishing pressure and liberal creel limits.

Site Description

Browns Lake lies adjacent to the main stem Blackfoot River (~ 4,300 ft elevation) and is surrounded by morainal 'knob-and-kettle' topography with numerous wetlands. It is a relatively shallow, meso-eutrophic natural lake, with abundant submerged vegetation and emergent shoreline vegetation. Although many springs are evident in the main lake basin and north arm (see Figure 1), water exchange in the lake is largely dependent on one small inlet and outlet (Ward Creek). Water surface elevation is controlled by the lake outlet, which has been raised and enhances storage for irrigation.

In addition to stocked rainbow trout, native longnose sucker, largescale sucker and red-side shiner are also present in Browns Lake. Longnose sucker are particularly abundant and make up the majority of the fish biomass. In recent years, brook trout have also been reported by numerous anglers. It is likely that theses fish originate in Ward Creek upstream of the lake, as an abundant population exists in this stream reach.

High underlying productivity and abundance of prey items drive trout growth rates in Browns Lake. Trout feed most heavily on freshwater shrimp (*Gammarus spp.*), but diverse and abundant insect hatches are also evident and reflected in trout diets. Trout flesh quality is generally excellent and carotenoids contained in shrimp exoskeletons produce a strong orange color in fillets that is highly desirable for anglers who choose to harvest fish.

The high underlying productivity and simple fish community at Browns Lake facilitate accelerated trout growth, but also contribute risk to fishery consistency and sustainability. Elevated oxygen demand (primarily in winter) and warm summer water temperatures lead to periodic water quality problems, bacterial infections, and other stressful conditions that can be difficult for trout to overcome. The result has been inconsistent survival of trout plants and occasional winter kill events.

Browns Lake is susceptible to winter fish kills because of its shallow bathymetry (Appendix A) and abundant submerged vegetation. Winter kills occur when dissolved oxygen is depleted under ice and snow cover. As winter progresses, deep snow typically diminishes sunlight penetration and submerged plants stop replenishing oxygen through photosynthesis. During this transition, oxygen demand increases as plants decay and draw oxygen from the water column. Fish may perish if they cannot find oxygenated refuge areas (e.g., springs) during the most severe periods. Most fish kills on Browns Lake have been incomplete and occur sporadically; typically when water levels are low and the duration of ice cover is extended. Fortunately, high stocking rates and trout growth rates facilitate rapid recovery of the fishery when winter kills occur.

Photo by L. Knotek

Gammarus spp. shrimp are a large component of trout diets in Browns Lake and contribute to excellent growth and flesh quality

Elevated summer water temperatures likely also impact survival, growth and catchability of trout stocked in Browns Lake. Surface temperatures routinely exceed 78^{o}F (25^{o}C) in late summer, which is stressful to coldwater fish such as trout. It is likely that the same springs that provide oxygenated water in winter, also act as thermal refuges for trout during warm summer months.

Angler Use and Public Access

Browns Lake provides a popular year-round fishery with good access for shoreline anglers and those with watercraft. Angling pressure is increasing and consists primarily of Montana residents (Figure 2). Most angling occurs during summer (open-water) months, but ice fishing continues to be popular. During open water seasons, anglers use a variety of techniques from shore and various watercraft: fly-fishing, trolling, live bait fishing with set lines, etc. Ice fishing is most productive and popular during ‘early’ winter (November-January), presumably prior to depletion of oxygen under the ice.

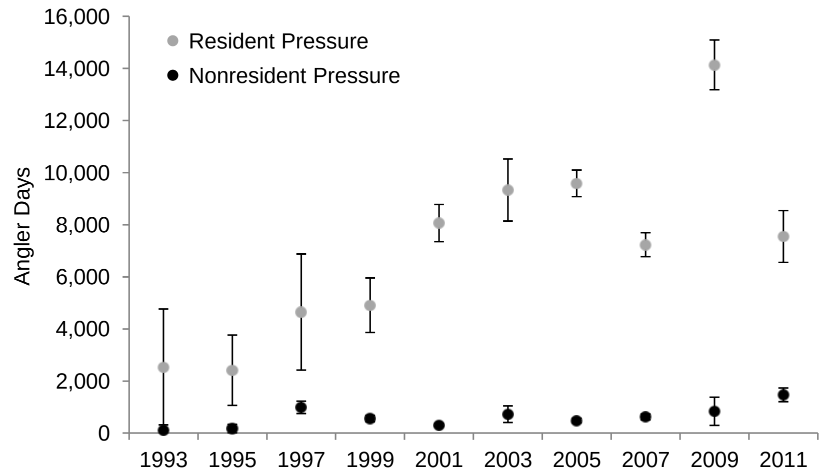


Figure 2. Estimated annual fishing pressure on Browns Lake for Montana residents and non-resident anglers, 1993-2011 (MFWP 2012).

Land ownership along the shoreline of Browns Lake is a mix of private, state, and federal holdings, but the perimeter remains almost entirely undeveloped. The only formal Fishing Access Site (FAS) has been managed by MFWP since 1992 and occurs on a private lease located on the large, south shore peninsula (see Appendix C). This site contains a concrete boat ramp, vault latrines and numerous dispersed camp sites. It can easily accommodate most fishing boats and provides ample room for large group camping and shoreline angling. Other publicly owned parcels provide additional shoreline angling opportunity and launch points for smaller watercraft, as well as access for ice-fishing in winter.

Anglers have historically enjoyed a high level of public shoreline access on Browns Lake, including developed FAS sites, undeveloped public holdings, and large private tracts where landowners allowed public use. Unfortunately, public access on private lands is becoming more restrictive. The Browns Lake FAS has been situated on the preferred lakeshore location (south peninsula) for more than two decades, but MFWP may be unable to continue the historic lease arrangement past 2016. If this occurs, alternative public sites will be evaluated and a new site will be developed. Overland access to private shoreline areas has also recently been restricted. MFWP is committed to working with private landowners to continue public shoreline access where possible.

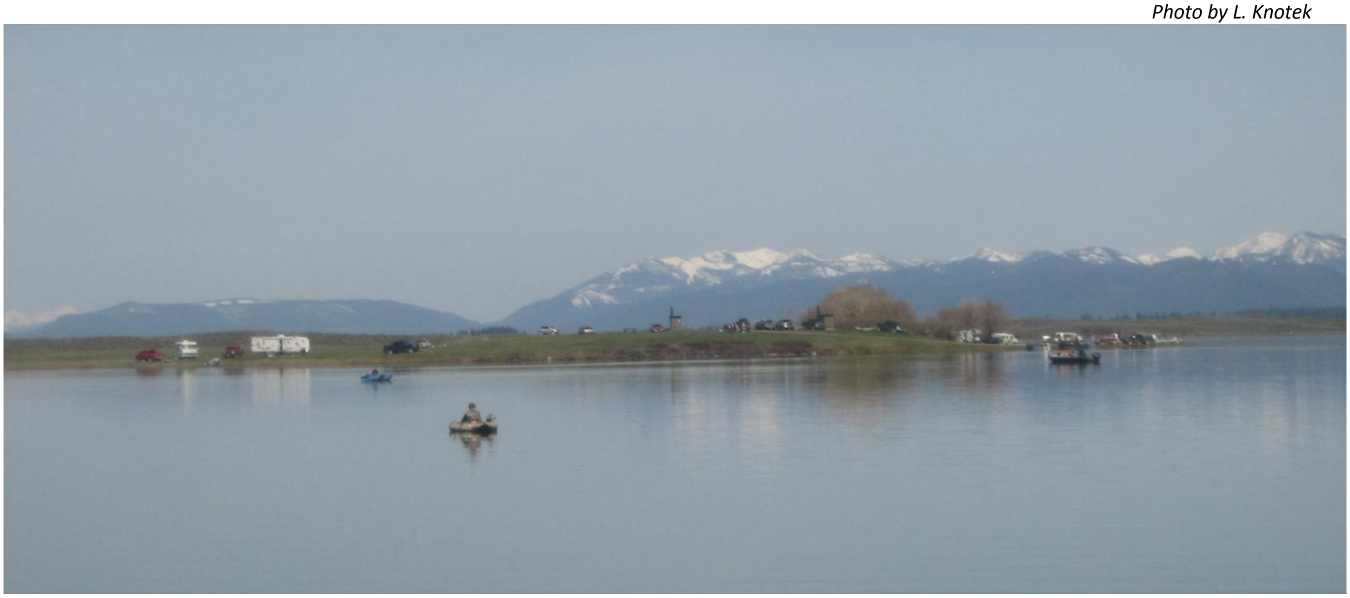
Rainbow Trout Stocking Program

Rainbow Trout Strains and Hatchery Sources

Browns Lake is currently stocked with *Arlee* and *Eagle Lake* strain rainbow trout. These fish are produced at the Jocko River and Giant Springs State Fish Hatcheries, respectively. Although other rainbow trout varieties are available in the state and federal hatchery systems, these two stocks have performed well in Browns Lake and contribute to fishery diversity (i.e., both harvest and trophy components).

The *Arlee* strain was first developed in the 1950s from McLeod River and Donaldson stocks (Ron Snyder, MFWP Hatchery Manager, personal communication). Brood stock are held at the Jocko River State Fish Hatchery and much of MFWP's production of this strain occurs there. *Arlee* rainbow trout normally grow rapidly, are readily catchable, maintain high body condition (plumpness) and mature at age-2 or age-3 in Browns Lake. In contrast, *Eagle Lake* rainbow trout are characterized by slightly slower growth and lower body condition, but appear to be less vulnerable to angling and mature at age-3 or age-4. This strain was established directly from wild fish collected in Eagle Lake, California in 1982-1984 (National Biological Survey 1994). The *Eagle Lake* brood stock is held at the Ennis National Fish Hatchery in Ennis, Montana, which distributes eggs to various production hatcheries such as Giant Springs State Fish Hatchery. The majority of rainbow trout harvested in Browns Lake are *Arlee* strain, while nearly all trout that reach 20 inches or larger are *Eagle Lake* strain.

Photo by L. Knotek



Browns Lake is a popular fishery that supports a diverse angling constituency

Timing, Composition, and Marking of Hatchery Plants

Rainbow trout year-class strength and fishery quality have historically been variable at Browns Lake. Annual differences in quantity and quality of stocked fish have contributed to inconsistency, but variability is primarily attributed to fluctuations in lake conditions (including water levels, primary production and severity of oxygen depletion in winter).

Given the instability in lake conditions, we began employing a more diversified stocking strategy to improve consistency of the fishery. The strategy included changes in stocking methods, locations, and timing, as well as incremental increases in number and size of stocked fish. The quality of hatchery products was enhanced (larger fish with higher condition) and we began marking individual plants to track relative growth and survival.

The length and body condition of stocked rainbow trout varies among strains and stocking dates (Table 1). The 'fall' stocking typically occurs in September, while the 'spring' stocking occurs in June, with the exact timing dependent on water temperature. Trout stocked in spring are generally smaller and likely exhibit lower survival in the lake, but grow much faster than fish retained in the hatchery until fall. Conversely, ‘fall’ plants are held in the hatchery several additional months to maximize size at time of stocking and survival during the first few months in the lake. The objective of all plants is to maximize size and condition of fish at time of stocking, but the relative benefits of spring and fall stocking varies annually with lake conditions and food availability.

Table 1. Average length and body condition of Age-0 *Arlee* and *Eagle Lake* rainbow trout at time of stocking in Browns Lake (2010-2013).

STRAIN	MEAN LENGTH (mm)	RANGE	MEAN CONDITION (Wr)	RANGE
Spring Arlee	117	77-150	83	60-97
Fall Arlee	158	140-169	94	90-98
Spring Eagle Lake	85	52-124	78*	42-97*
Fall Eagle Lake	161	86-206	85	73-109

* Data from measurements obtained in 2012 only

A marking scheme was developed to evaluate the performance of individual strains and stocking events. All Eagle Lake plants were batch marked with 8-10 day exposures to oxytetracycline administered as a food supplement. This chemical is a photo-reactive antibiotic that fluoresces under black light and can be identified in calcified structures (e.g., vertebrae or otoliths) for several years after exposure. Fall Arlee rainbow trout were identified with a clipped adipose fin, while spring Arlee plants had no distinguishable marks. Identification of unmarked fish as ‘spring Arlee’ plants was considered reliable as successful natural reproduction of rainbow trout has not been documented in Browns Lake.

Beginning in 2008, strategic changes in stocking methods were also implemented. The most significant change was distribution of fish by boat throughout the entire lake, instead of shore plants directly from the truck at a limited number of locations on the west and south shore. Wide distribution by boat was employed to reduce susceptibility to avian predation and to facilitate immediate use of food resources and optimal habitats throughout the lake.

Stocking Rates

Stocking rates from 2008-2013 were 50,000-65,000 juvenile rainbow trout per year, but generally were increased incrementally beginning in 2010 (Table 2). These rates are similar to the average from 2000-2007 ($\bar{x}$= 57,200), but annual variability was much less during our study period (range 32,500-103,900 fish stocked annually in 2000-2007). We suspect that survival of stocked fish was significantly increased during this study, due to increased quality of plants and improved stocking methods. Declines in fish body condition, as well as increasing gill net catch rates, support this notion and suggest that continued refinements in stocking rates are warranted.

Evidence of Natural Reproduction

Adult rainbow trout are frequently observed spawning in the inlet and outlet of Browns Lake (Ward Creek), as well as along the shorelines where pockets of gravel are available. Based on recent lake surveys, hatchery trout marking schemes, and electrofishing in Ward Creek, it appears that natural reproduction of rainbow trout is absent or extremely limited. Spawning success is likely limited by lack of suitable habitat for egg incubation in the lake and rapid dewatering of Ward Creek after spring runoff.

Table 2. Stocking rates for rainbow trout in Browns Lake since 2008. Numbers in parentheses represent mean size (inches) of fish stocked.

	SPRING		FALL		
YEAR	**ARLEE**	**EAGLE LAKE**	**ARLEE**	**EAGLE LAKE**	**TOTAL**
2008	17,500 (4.9)	15,000 (3.4)	17,800* (4.9)	0	50,300
2009	17,500 (5.1)	16,200 (3.2)	17,900* (5.6)	0	51,600
2010	18,100 (3.7)	15,000 (3.1)	17,200 (6.0)	0	50,300
2011	17,800 (4.1)	16,200 (2.9)	20,400 (5.6)	0	54,400
2012	18,400 (4.8)	17,000 (3.3)	20,000 (6.4)	8,900 (6.2)	64,300
2013	15,600 (5.0)	13,700 (3.9)	19,900 (6.6)	11,400 (6.1)	60,600
2014	*10,000*	*10,000*	*15,000*	*6,000*	*41,000* #

*Sterile (triploid) Arlee rainbow trout were stocked in fall 2008 & 2009
#2014 values represent number of fish requested from hatcheries

Other Species Considered

Rainbow trout have been the predominant species stocked in Browns Lake in recent decades, but stocking records since the 1930's indicate that cutthroat trout, Coho Salmon, Chinook Salmon, and kokanee (sockeye salmon) have also been planted. Although various anglers have suggested re-instituting westslope cutthroat trout, brown trout and kokanee stocking, most constituents are satisfied with the current fishery (MFWP 2011). Rainbow trout currently provide a quality fishery with high catch rates and outstanding flesh quality. Given the uncertainties associated with introducing new species, stocking of additional sport fish is not recommended unless significant problems arise with the rainbow trout fishery.

Fishery Monitoring

In 2009-2013, MFWP increased monitoring effort at Browns Lake to better evaluate the rainbow trout stocking program and fishery. Our objective was to develop standardized methods that would facilitate sound fishery management recommendations. These recommendations were meant to improve fishery size structure (i.e., harvest quality) and consistency (i.e., high year-to-year angler success). Annual rainbow trout length-frequencies, growth rates and survival data were obtained primarily through gill net surveys.

Annual Gill Net Surveys

Rainbow trout were sampled with experimental gill nets from 2009-2013 in late fall (late October - early November). Experimental gill nets were 6-ft (height) x 125-ft long, with five graduated panels of 0.75, 1, 1.25, 1.5 and 2 inch bar-mesh monofilament. Nets were set before dusk and retrieved the following morning, with one "net-night" roughly equaling a 12 hr set. Fish were sorted as they were retrieved from the nets and later processed to obtain length, weight and marking information. We initially deployed floating nets exclusively for sampling to minimize catch of non-target species (e.g., suckers). When it became apparent that fewer rainbow trout were collected in floating nets during periods of low water clarity and changing weather patterns, sinking gill nets were incorporated (2012-2013) to ensure adequate sample sizes and year class representation. Sinking gill nets were more effective at capturing trout during these periods of limited activity, but we continued to primarily set floating nets to balance sampling effectiveness and limiting by-catch of non-target species. We also gradually increased the total number of nets set (effort) to help ensure consistency among years, despite variable environmental conditions. Current methods call for 10-11 net sets, including at least three sinking gill nets.

Standardized net locations were established over time and finalized in 2013 (see Appendix B). Net type (sinking or floating) varies by location, with depth of sets ranging from 6-22 feet. In 2012, two surveys were conducted because turnover of the lake resulted in low total catch during the first survey. The timing of turnover will be more closely monitored in future years to avoid sampling during this period of mixing and low fish activity. Surveys will continue to be planned for late October to maintain sampling consistency and avoid periods of high recreational use on the lake.

Trout Population Data

We collected nearly 400 rainbow trout in fall gill net sets from 2009-2013 and standardized catch rates (number/ net night) were calculated from these surveys (Figure 3). Annual rainbow trout catch rates varied somewhat over this period and likely reflect actual changes in abundance for fish larger than 200 mm. The exception may be 2012 samples where netting coincided with fall lake turnover and relative abundance may be significantly under-represented based on comparison of growth rates and condition over the study period (see Figures 4 & 5 below).

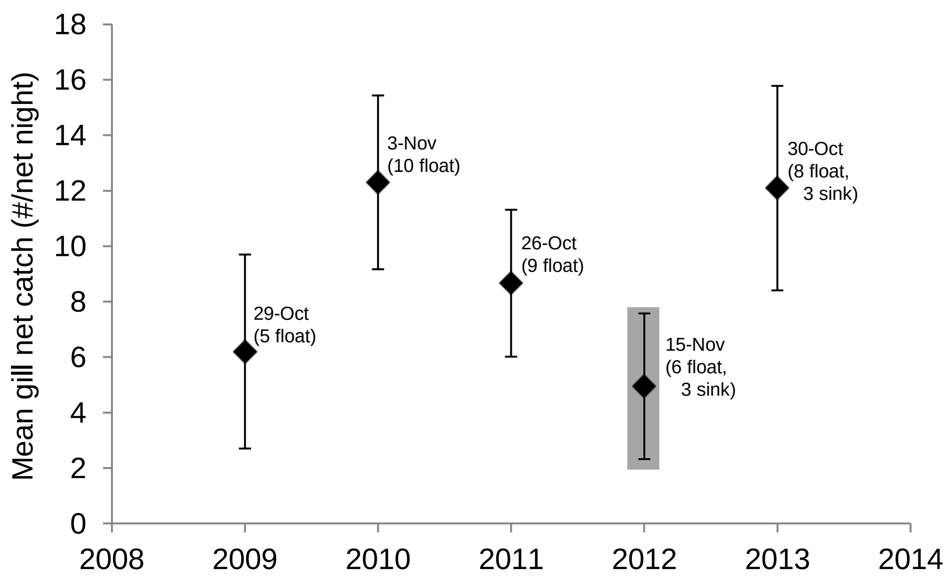


Figure 3. Mean catch rates and standard deviation for rainbow trout in gill net sampling, 2009-2013. Data from 2012 (highlighted) are suspect due to sampling during fall lake 'turnover' period.

Length-frequency histograms for 2010-2013 illustrate annual differences in the size distribution of all rainbow trout sampled in Browns Lake (Figure 4). Some of this variation is likely due to incremental changes in stocking density, timing and methods that we implemented during the study, but the figure also incorporates annual disparity in survival of plants due to changing lake conditions. Results from 2010 also reflect the absence of triploid Arlee rainbow trout stocked in 2008 and 2009 (low abundance of fish 400-450 mm). A target sample size of 100 rainbow trout (minimum) is recommended in future years for adequate representation of population size structure.

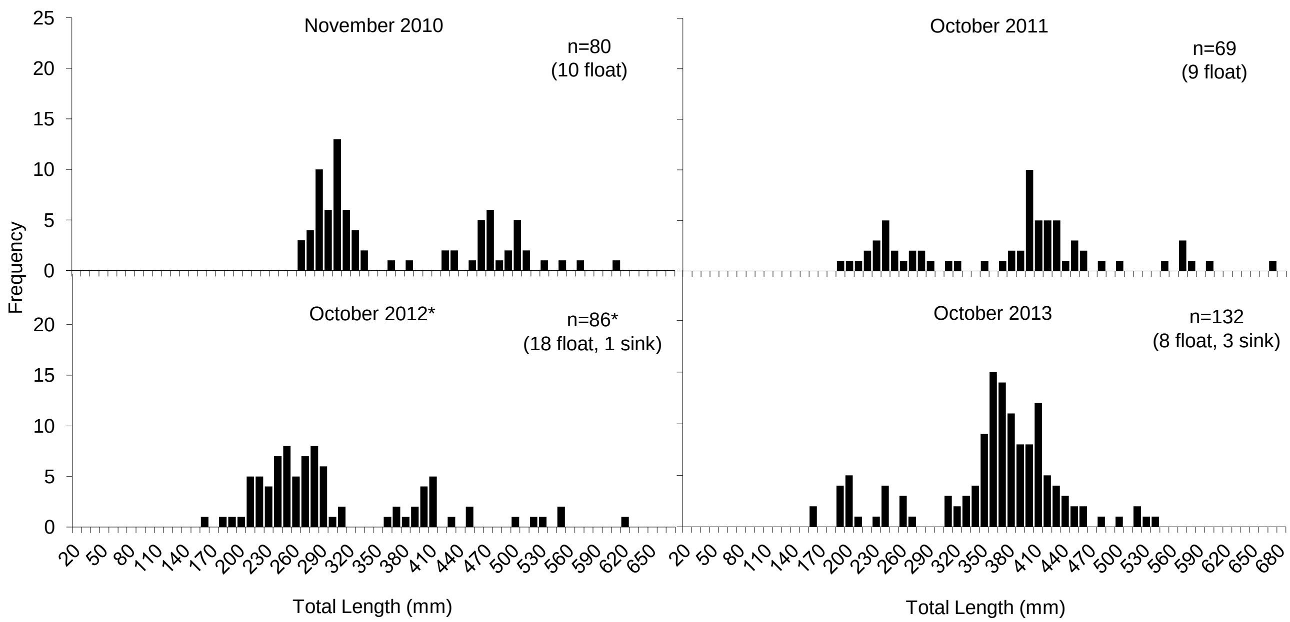


Figure 4. Length-frequency histograms for rainbow trout captured in Browns Lake, 2010-2013.

Trout Growth Rates and Condition

Average daily growth rates were calculated for fall stocked *Arlee* rainbow trout (2009-2013) to illustrate growth trends among years and stocking densities. Growth rates for the *Eagle Lake* strain are slightly lower. The fall *Arlee* plant was generally the most abundant in gill net samples and the most reliably identified in the field (adipose fin clip). Growth rates were calculated with:

$$G = \left(\frac{I - R}{D}\right)$$

G = estimated growth,
I = mean initial length,
R = mean recapture length,
D = days elapsed since release.

Daily growth rates of fall-stocked Arlee rainbow trout declined from 2010-2013 (Figure 5). This trend was likely due to increased stocking rates and less suitable growing conditions in the lake (particularly 2012 and 2013). In both of these years, lake surface elevations were low and summer temperatures were warmer than average.

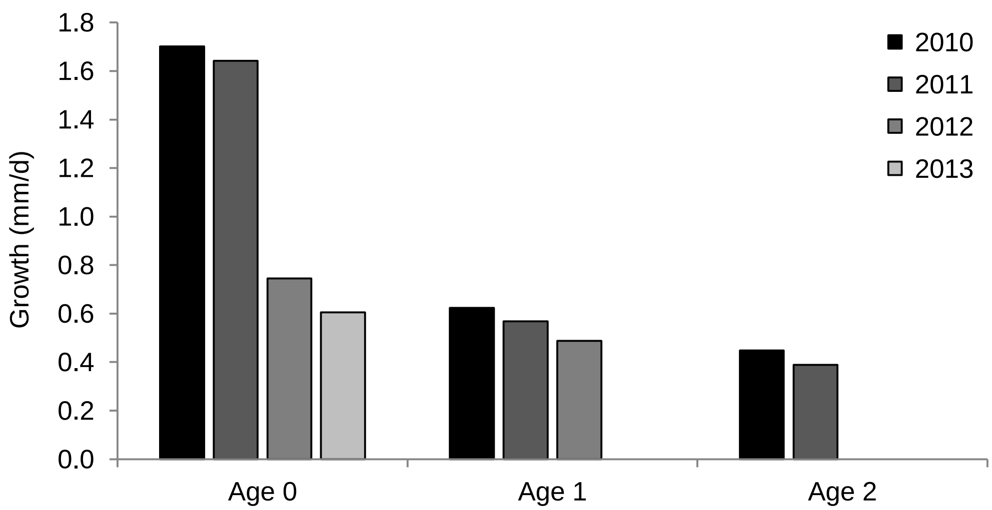


Figure 5. Average daily growth rates for *Arlee* strain rainbow trout stocked in fall at Browns Lake, 2010-2013.

Fish condition (plumpness) was estimated for both strains of rainbow trout in 2010-2013 using the following equations:

$$\log_{10}(W_s) – M + b \times \log_{10}(L)$$

W_s = standard weight,
M = intercept (-4.898),
b = slope of the intercept (2.99),
L = length of the individual.

This standard weight (W_s) was then used to determine the condition (W_r) for each individual with:

$$W_r = (W/W_s) \times 100$$

W_r = condition,
W = actual weight,
W_s = standard weight.

The calculation of condition (W_r) describes the relative ‘plumpness’ of an individual fish in comparison to a standard (W_s) for a given species within a given habitat; in this case lentic rainbow trout. Individuals with higher values of W_r are considered to have better condition. For reference, a Wr value of 100 is considered average for a fish when conditions are suitable for the species (Anderson and Neumann 1996).

Similar to average growth rates (length) described above, the condition of all rainbow trout strains in Browns Lake declined in 2010-2013 (Figure 6). This decline was likely also related to increased stocking rates and fish densities during a period of declining lake suitability for trout growth. Smaller average size and condition in our samples was consistent with trout caught by anglers during this period.

Despite lower growth and condition, angler reports (anecdotal) indicated that angler catch rates and satisfaction did not decline in 2010-2013. Nonetheless, we intend to reduce stocking rates in 2014 to balance fish density, growth rates and average size in Browns Lake. These annual refinements in stocking will likely continue as new information becomes available.

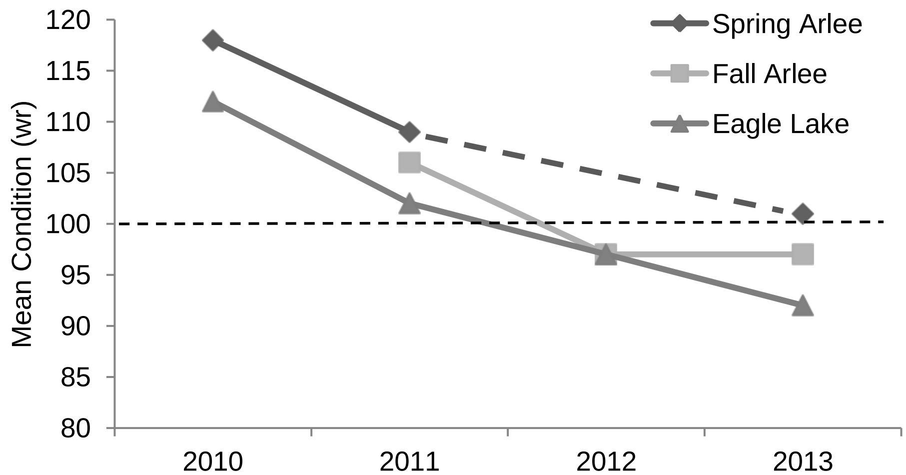


Figure 6. Mean rainbow trout condition (Wr) over time for Arlee and Eagle Lake strains in Browns Lake.

Performance Comparison for Different Rainbow Trout Strains

Relative survival and growth rates varied between the two strains of rainbow trout stocked in Browns Lake. Annual monitoring confirmed that Arlee rainbow trout grew faster, matured earlier and maintained higher body condition than Eagle Lake strain rainbow trout. However, the Eagle Lake strain appeared to be less susceptible to angling and made up the majority of the trophy fish component (see Figures 7 and 8).

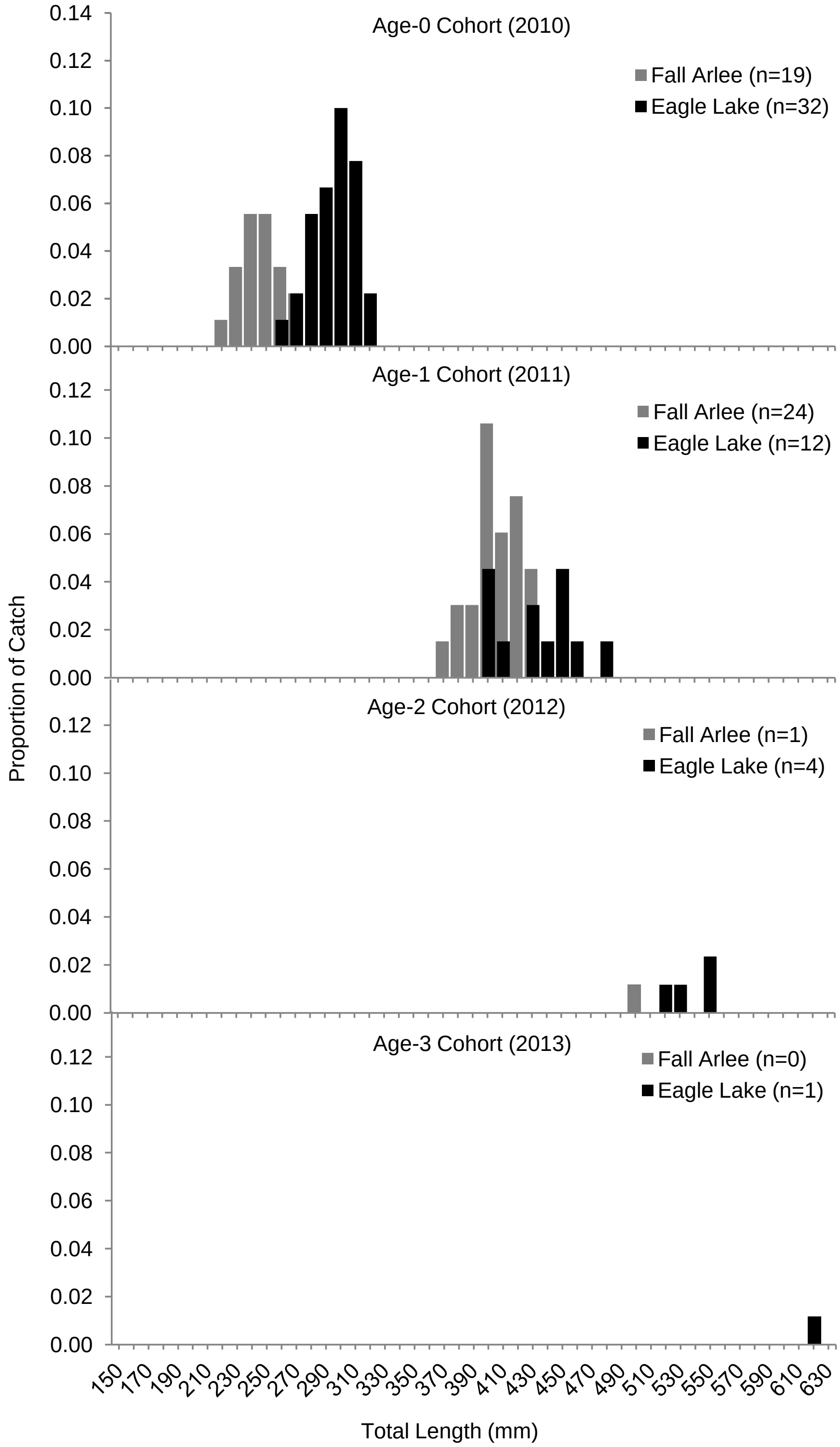


Figure 7. Cohort growth and relative abundance over time for rainbow trout stocked in Browns Lake in 2010.

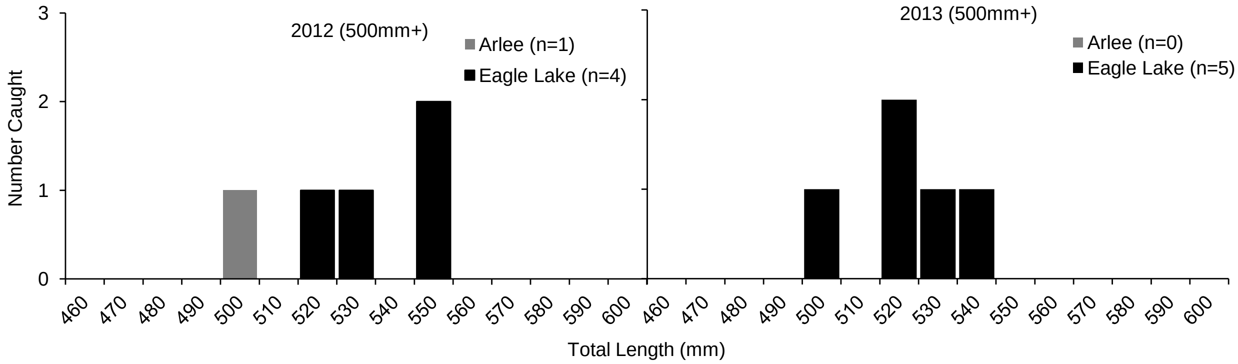


Figure 8. Size and composition (strain) of the largest rainbow trout sampled in Browns Lake in 2012 and 2013.

The composition of gill net catch varied annually, but catch rates for *Arlee* strain rainbow trout were typically greater than catch rates of *Eagle Lake* strain rainbow trout (Figure 9). The exception was in 2010, when catch of fall planted Arlee rainbow trout from previous years was minimal. Although a greater number of Arlee strain were stocked in 2008 and 2009 (see Table 2), all fall-stocked *Arlee* strain rainbows were sterile (triploids) and their survival was very low. Arlee rainbow trout represented in the 2010 gill net catch consisted of fish stocked in the spring. The failure of the 2008 and 2009 fall Arlee stocking events illustrates the value of a diversified stocking strategy, with different trout strains and variable stocking dates.

Photo by Phil Backofner

Although Browns Lake provides a popular harvest fishery, many anglers target the trophy component that is primarily comprised of Eagle Lake strain rainbow trout

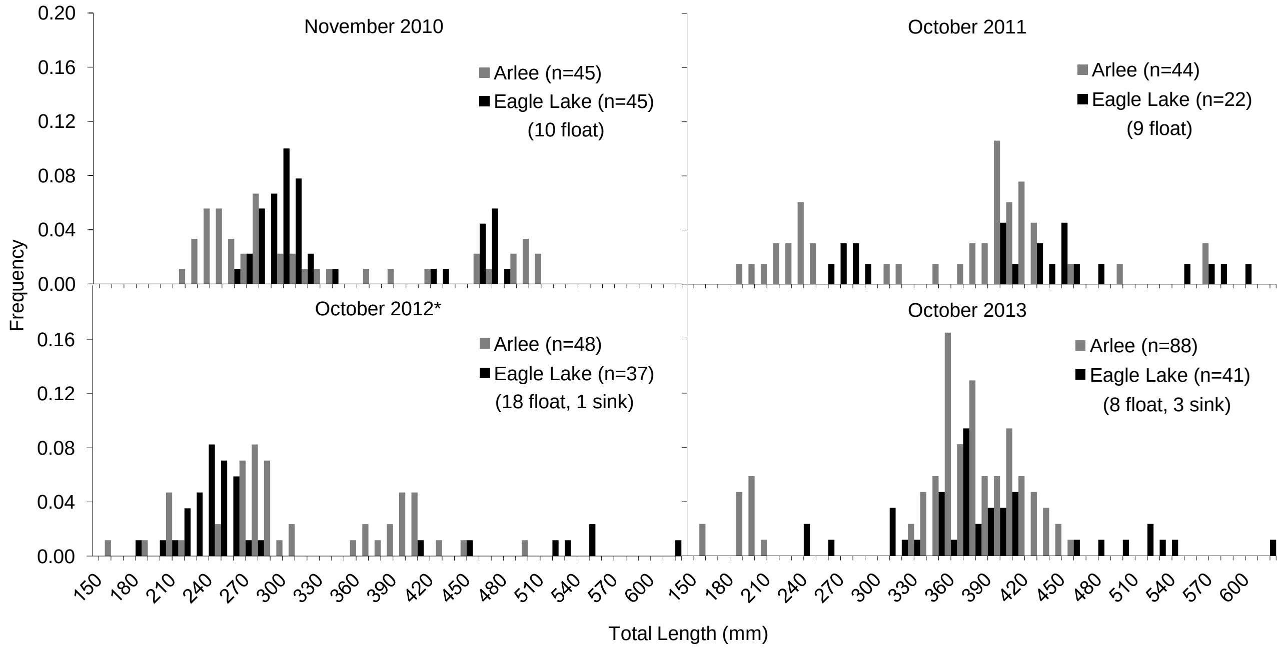


Figure 9. Rainbow trout strain and size distribution in gill net catch from Browns Lake 2010-2013.

Management Recommendations

Stocking Program

Based on incremental stocking changes and evaluations in 2008-2013, we recommend an annual stocking rate of 40,000 – 50,000 fingerling (YOY) rainbow trout at Browns Lake to maximize quality and consistency of the current fishery. This rate assumes that current stocking practices and fish specifications are maintained: Arlee and Eagle Lake strain rainbow trout, spring and fall boat plants, minimum average stocking size of 4 inches (spring) and 6 inches (fall), optimized plant timing based on water temperature (< 15 C), etc. Incremental adjustments in stocking timing and methods should continue, with the goal of establishing a schedule that is sustainable for management and hatchery personnel.

Stocking of triploid (sterile) rainbow trout is not recommended based on poor survival of initial trials. These results are consistent with findings in Idaho where sterile rainbow trout performed poorly in low elevation lakes and reservoirs; particularly in waters with stressful physical conditions such as high summer water temperatures and low winter oxygen levels (Koenig and Meyer 2011). Experimental stocking of longer-lived, later maturing rainbow trout strains (e.g., Girard) is recommended when fish are available.

Monitoring

Continuation of standardized fall gill-netting (late Oct/early Nov) is recommended as the primary fishery monitoring tool, with a minimum target sample size of 100 fish each year. Survey locations should be expanded to include the north arm of the lake and sampling near the period of lake turnover should be avoided. Marking of individual plants should continue as long as practicable to allow reliable strain differentiation and provide performance data. The impact of unsuitable water quality conditions (e.g., oxygen depletion and elevated water temperature) should be evaluated annually. Regular, standardized angler creel surveys that evaluate angler harvest, catch rates and satisfaction should also be incorporated into the long term monitoring program.

Fishing Regulations

Current angling regulations on Browns Lake allow liberal, year-round harvest and provide moderate protection of potential trophy fish (5 rainbow trout daily, one over 22 inches), as per standard creel limits for the Western Fishing District. The lake has produced low numbers of rainbow trout > 28 inches within the last decade, but intensive angling pressure and harvest limit survival rates for larger fish. If a higher quality trophy fishery is desired by constituents, more protective length restrictions are likely warranted.

Unauthorized introduction of new plant and animal species is a growing threat for western Montana lakes, but particularly for waters such as Browns Lake with heavy use and high boat traffic. Public outreach and education should be an emphasis, as well as increased enforcement and penalties for violators.

Public Access

The perimeter of Browns Lake includes both public and private ownership (see appendix C). Currently, the primary public access point (including improved boat ramp, camping, etc.) is located on leased private property. MFWP should continue to pursue and prioritize options that retain public access on this property, but escalating costs may force development of an alternative site on existing public lands by 2016. In either case, MFWP will provide opportunity for public boat access and camping at the lake.

Overland access to private shoreline areas is also an important component of angler access. Although many private properties have recently restricted access to the lake, MFWP should continue to pursue access opportunities for shoreline anglers on private lands where they exist.

Lake Level Management

Browns Lake surface elevation is significantly influenced by the magnitude of spring runoff, but is ultimately controlled by the capacity and elevation of the lake outlet. Enhancements to maximize lake pool elevation and storage (through management of the outlet structure) may be possible, but depend on water supply and cooperation by affected landowners and irrigators.

Acknowledgments

Thanks to the staffs at the Washoe Park and Giant Springs State Fish Hatcheries for their help, insights and dedication on this project, including: Ron Snyder, Charlie Bridgham, Jeff Lammerding, Stephanie Espinoza, Ryan Derr and Matt Whipf. Ron Pierce reviewed the document and provided helpful edits.

Literature Cited

Anderson, R.O. and R.M. Neumann. 1992. Length, Weight and Associated Structural Indices. *In* FisheriesTechniques; B.R. Murphy and D.W. Willis, eds. American Fisheries Society, Bethesda, Maryland. pp 447-482.

Koenig, M.K. and K.A. Meyer. 2011. Relative Performance of Diploid and Triploid Catchable Rainbow Trout Stocked in Idaho Lakes and Reservoirs. North American Journal of Fisheries Management 31:605-613.

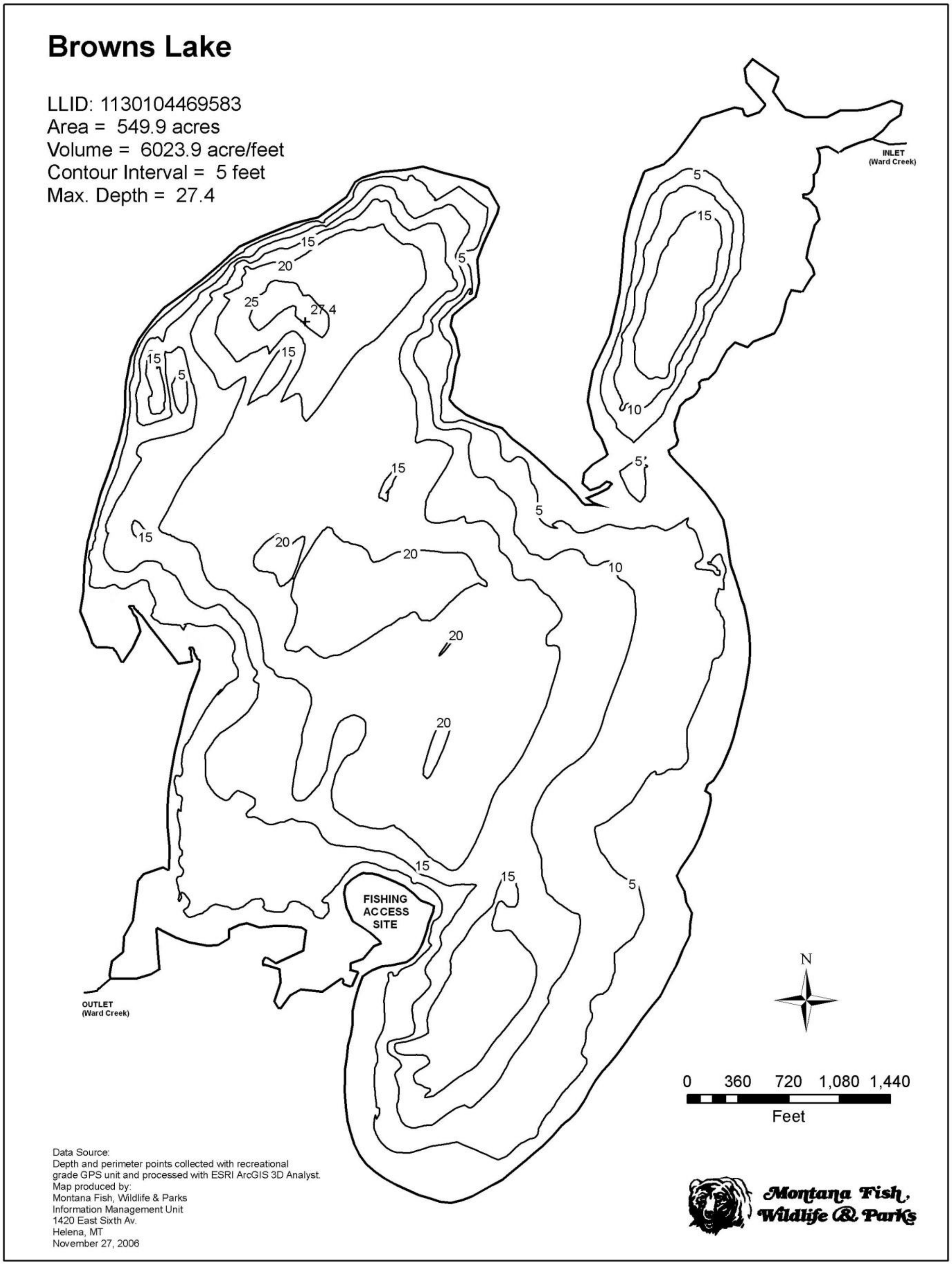
Knotek, W.L., W.J. Schreck, R.A. Rashap and J.C. Thabes. 2013. Mountain lake surveys and fisheries management recommendations for Rattlesnake Wilderness Lakes. Montana Fish, Wildlife & Parks, Missoula, Montana.

Knotek, W.L. and J.C. Thabes. 2008. Mountain lake surveys and management plan for the middle Clark Fork Region of the Bitterroot Mountains. Montana Fish, Wildlife & Parks, Missoula, MT.

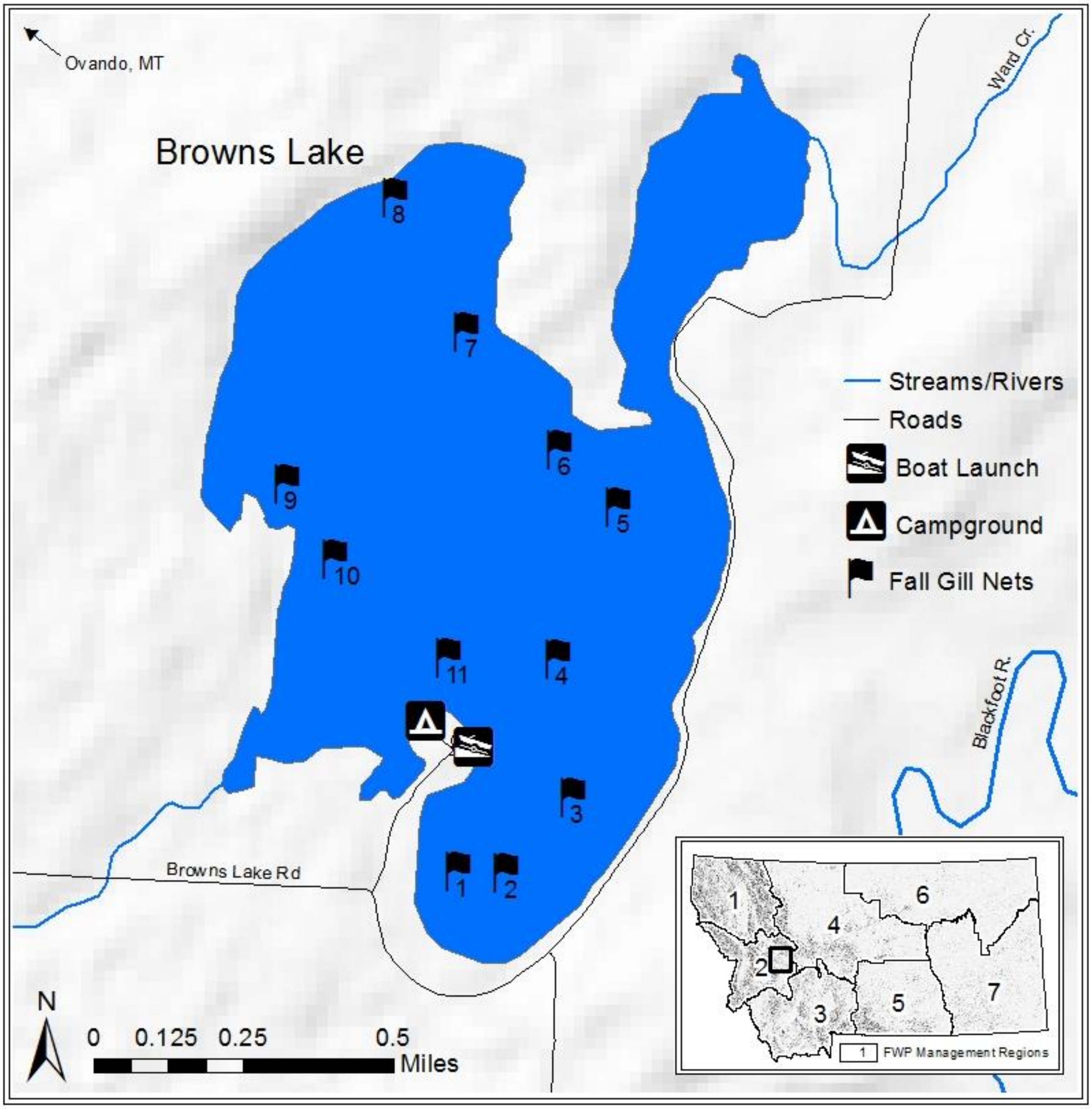
MFWP. 1995-2013. Montana statewide angling pressure summaries. Montana Fish, Wildlife, and Parks, Helena, Montana.

Research Information Bulletin. 1994. In Lake DeSmet, Wyoming, fish are rare in the diet of Eagle Lake strain rainbow trout. U.S. Department of the Interior – National Biological Survey. 1994:2.

Appendix A – Browns Lake Bathymetry



Appendix B – Fall Gill Net Locations for Standardized Sampling at Browns Lake



Appendix C – Browns Lake Area Land Ownership